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Reduced Stereoacuity in Williams Syndrome

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Strabismus is a frequently recognized manifestation of Williams syndrome [Greenberg and Lewis, 1988: Ophthalmology 95:1608–1612; Kapp et al., 1995: Am J Ophthalmol 119:355–360]. We recently evaluated the ophthalmologic function of 12 patients with Williams syndrome (WS), with an emphasis on binocularity. Four of 12 patients (33%) had measurable strabismus. Of the 8 remaining patients, examination of binocular function was possible in 6, all of whom demonstrated reduced stereoacuity. We speculate that subnormal binocular vision and the poor visuospatial performance observed in patients with WS may be related to abnormal brain morphogenesis in the region of the occipitoparietal cortex.

KEY WORDS: Williams syndrome, strabismus, binocular vision

INTRODUCTION

Previous reports of ophthalmologic findings in Williams syndrome (WS) have included a stellate iris stromal pattern, hypermetropic discs characterized by high branching of the central retinal vessels and slight flattening of the optic cup, and situs inversus vasorum in which retinal vessels traverse the nasal retina before entering the temporal arcades [Greenberg and Lewis, 1988]. Strabismus, most often esotropia, is also common [Greenberg and Lewis, 1988; Kapp et al., 1995]. The purpose of this report is to further delineate the ophthalmologic manifestations of patients with WS, with emphasis on binocular function.

MATERIALS AND METHODS

Five males and 7 females were referred from an interdisciplinary WS clinic following diagnosis by a clinical geneticist (L.S.S.). Patient ages ranged from 18 months–24 years, with a mean age of 8 years, 2 months. In all cases, fluorescent in situ hybridization (FISH) studies disclosed a submicroscopic deletion in the region of the elastin gene.

A complete ophthalmologic examination, including evaluation of binocular function, was performed by a pediatric ophthalmologist (S.E.O.). Ocular alignment was measured in all patients, using an alternate cover test. Binocular function was evaluated using the Worth four-dot test and the Titmus test. The Worth four-dot test is used to determine the presence or absence of a central suppression scotoma. This scotoma is not present in patients with normal binocular vision, but may be present in patients with reduced binocularity. Polaroid vectographs using the Titmus stereo test were used to measure the presence and degree of near-stereopsis in those patients who demonstrated reduced binocular function. Bifoveal fixation, or normal binocular vision, was defined as stereoacuity of better than 60 sec of arc.

RESULTS

Patient findings are summarized in Table I. Four of 12 patients (33%) had a nonaccomodative esotropia. Of the remaining 8 patients, examination of binocular function was possible in 6, all of whom demonstrated reduced stereoacuity. Measurement of binocular function was not possible in 2 patients due to their inability to cooperate with testing. No patient was found to be amblyopic.

DISCUSSION

The observed frequency of esotropia in the patients of this report is similar to the observations of others. For example, Greenberg and Lewis [1988] found strabismus in 12/26 (29%) patients examined. In Kapp et al. [1995], esotropia was observed in 23/32 (72%) patients. Abnormalities of binocular vision appear to be a previously unrecognized manifestation of WS. Of the 6 patients without a measurable strabismus in whom examination of binocular function was possible, reduced stereoacuity was demonstrated in all cases. This finding suggests a congenital defect of the binocular sensory system.

Stereoacuity refers to the ability to extract depth from two slightly disparate two-dimensional retinal images [Westheimer, 1994]. The task of extracting three-

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TABLE I. Ophthalmologic Findings in Williams Syndrome

Patient	Age (years)	Gender	Strabismus[a]	Stereoacuity (sec of arc)
1	2	F	20	None
2	3	M	30	None
3	6	M	15	None
4	8	M	20	None
5	1.5	F		Unable
6	5	F		Unable
7	7	F		140
8	8	F		200
9	8	M		140
10	10	M		140
11	18	F		140
12	24	F		800

[a]Esotropia in prism diopters.

dimensionality falls on the central nervous system. Electrophysiologic single-cell studies of nonhuman primates have linked binocular function to visual cortical regions 17 and 18 [Poggio and Poggio, 1984]. More recent studies using PET scanning in healthy adult males have demonstrated that most binocular disparity-sensitive cells are located in the occipital and parietal lobes, although prefrontal cortical and cerebellar regions may also be involved [Ptito et al., 1993; Gulyas and Roland, 1994].

With respect to neuroanatomic findings in WS, MRI studies have disclosed a relatively diminished posterior brain width, an elongated anteroposterior dimension, and preservation of the neocerebellum [Bellugi et al., 1990; Wang et al., 1992]. Gross examination of the brain of an adult with WS showed decreased size of the parietal, posterior temporal, and occipital regions, with small abnormal gyri in the region of the mesial occipital surface [Galaburda et al., 1994]. Histopathologic studies of the same patient showed scattered areas of immature neuronal organization, most notable in the region of the visual cortex. These findings, although limited, suggest that the subnormal binocular vision of the patients herein presented may be explained by altered brain morphogenesis in the occipitoparietal regions.

Data from humans and nonhuman primates also suggest that the visual areas of the occipital and parietal lobes may be involved in visuospatial processing [Ungerleider and Mishkin, 1982; Haxby et al., 1991]. Ungerleider and Mishkin [1982] proposed the existence of two distinct functional visuospatial pathways: an occipitoparietal pathway which is involved in the perception of visual information and visuomotor performance, and an occipitotemporal pathway which is involved in the analysis of visual information relevant to object recognition. Supportive evidence comes from studies of patients with isolated brain lesions. For example, patients with occipitoparietal lesions show impaired stereoacuity and poor visuospatial performance [Vaina, 1994], findings similar to those observed in patients with WS. Moreover, such patients show preservation of facial and object recognition, a finding that also characterizes the neuropsychological profile of patients with WS.

In conclusion, subnormal binocular vision with reduced stereoacuity is a newly recognized ophthalmologic finding in WS. We speculate that abnormal brain morphogenesis, primarily in the occipitoparietal regions, may account for this finding. We further suggest that altered brain development involving the occipitoparietal regions may similarly contribute to the severe visuospatial deficits observed in patients with WS.

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